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Evolving Role of EHS Manager in Industrial Sustainability Programs — Case Studies Incorporating a Pollution Prevention Approach to Problem Solving

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ABSTRACT: The role of the Environment, Health and Safety (EHS) Manager has evolved over the last two decades. For many companies, the focus of the EHS Manager is shifting from solely a regulatory compliance and waste treatment or waste disposal role to incorporating a green engineering and pollution prevention approach when solving environmental problems. It is critical for the EHS Manager to have a strong understanding of Environmental Management Systems (EMS), regulatory requirements, and ISO standards pertaining to environment, health, and safety. However, having the ability to go beyond this realm and collaborate with manufacturing personnel to determine opportunities for cost savings as it pertains to environmental reductions is crucial. Reducing environmental impacts often has a direct relationship with reducing impacts on the health and safety of the organization's personnel as well. This paper will focus on case studies surrounding projects where the New York State Pollution Prevention Institute (NYSP2I) has worked with companies where pollution prevention is becoming a focus of the EHS Manager's role. The effectiveness of this approach versus waste treatment or management solutions will be quantified by showing both the environmental and cost savings.

I. INTRODUCTION

The role of the Environment, Health, and Safety (EHS) Manager in the manufacturing sector has changed over the last two decades and continues to evolve (Barron, 1994, Fiksel, et. al., 2004). According to the National Association for EHS Management (NAEM), the corporate EHS function has its origins in three distinct professions – Environmental Management, Workplace Safety, and Occupational Health – that began to merge at the management level around 1990. Environmental Management emerged as a profession in the 1970s following the creation of the United States Environmental Protection Agency (USEPA) and other state-level regulatory systems. Workplace Safety and Occupational Health also grew in importance during this time, with the passage of legislation such as the Occupational Safety and Health Act of 1970.

Over time, as companies began to develop a systematic way of complying with environmental,

health and safety regulations, corporations began tracking key measures and looking for ways to improve their performance. In the 1990s, improvements in data technology management made it easier for an organization to analyze its operations. Around that time, corporations began to merge oversight for environmental, health and safety programs through a new management role called EHS. The newly appointed leaders, who began their careers in one of the three sub-disciplines, started to create systems to drive EHS progress across all operations.

Thus, the traditional functions of EHS managers (Figure 1) have included the three areas of:

1. Environmental Management
2. Occupational Health
3. Workplace Safety

Figure 1: Traditional Functions of EHS Managers

This paper focuses principally on the evolution of the EHS Manager's role in the context of environmental management. However, it is evident that a preventative and conservation-based approach has direct impacts on Occupational Health and Workplace Safety in manufacturing environments. For example, switching from a hazardous substance to a non-hazardous alternative in a manufacturing process mitigates the risk to people, and the environment.

Thus, one of the primary factors driving the continuing evolution of the EHS Manager's role is that companies are expanding their focus from conventional "end of pipe" activities focused on waste treatment for regulatory compliance to that of pollution prevention and sustainable production which involves reduction at the source in energy usage, waste generation, material substitution, along with greater recycling and reuse of resources. This strategic refocusing of an organizations operation could be defined as an *Internal Influencer*. In other words, the influence or impetus for the evolution came from within the organization due to changes in the corporate strategy and business outlook.

Other factors include reporting requirements (such as reporting to USEPA's Toxics Release Inventory) that result in large amounts of environmental release information becoming available in the public domain. This publicly available information has put a spotlight on the environmental impacts of companies and resulted in greater community awareness, increased risk to company reputation and an expectation of greater accountability from all stakeholders. This could be defined as an *External Influencer* where factors outside of the organization's direct control influence its future direction. Internal and External Influencers are discussed in greater detail in subsequent sections.

These factors have put demands on companies to better manage their environmental responsibilities (Chambers 2001). This shift has presented a great opportunity and challenge to EHS Managers, whose environmental efforts have traditionally been driven by corporate policies of meeting regulations and a desire to avoid significant legal and financial liabilities for their business (Dechant et al. 2005). Environmental

sustainability, or the need to protect the environment and conserve natural resources, is a value now embraced by the most competitive and successful multinational companies (Berry & Rondinelli 1998).

The expansion of the EHS Manager's roles and responsibilities into the sustainability arena has been observed firsthand by the New York State Pollution Prevention Institute (NYSP2I) in the process of providing assistance to companies around New York State. NYSP2I, a statewide research and technology transfer center (funded primarily by the New York State Department of Environmental Conservation [NYSDEC]), provides a statewide, comprehensive, and integrated program of research, technology development and diffusion, outreach, and training and education aimed at making New York State more sustainable for workers, the public, the environment, and the economy. In the three years of existence the NYSP2I has provided pollution prevention assistance to over 150 companies.

In many joint projects between NYSP2I and manufacturing organizations, the EHS Manager has played a critical role in reaching a successful project outcome, whether it was providing data for an initial environmental sustainability assessment and identifying environmental improvement opportunities, performing a feasibility study to validate a proposed environmentally preferable technology or solution, or leading the implementation of an environmentally preferable technology into their manufacturing process. In all instances, proactive collaboration characterized by greater communication and open sharing of opportunities or barriers among the EHS Manager and manufacturing personnel at the organization was required. This collaborative relationship of the EHS Manager with manufacturing personnel on pollution prevention projects is still being adopted by many companies. Focusing on cost reduction and manufacturing process optimization opportunities have not been commonplace activities for EHS Managers. However, as more organizations adopt sustainable practices (specifically in the realm of environmental sustainability), EHS Managers are expected to take on more, and in some cases, radically new responsibilities. This necessary evolution of the organization, along with the evolution of the role of the EHS Manager, comes with challenges for both. However, these changes have the potential to bring significant benefits that positively impact all three dimensions (people, planet, and profit) of sustainability.

II. FACTORS INFLUENCING THE EVOLUTION OF THE EHS MANAGER'S ROLE

An increasing number of companies have moved away from the view that environmental management focuses only on compliance with current laws and regulations to the understanding that environmental management is a legitimate business function driven by, among other things, legislation, markets, relationships in the supply chain, investors, and local communities and activist groups (Roome 1998).

Additionally, the rapid increase in regulations since 1970 (Figure 2) suggests that working only towards compliance is like trying to hit a rapidly moving target. Becoming proactive with pollution prevention and sustainability initiatives is a means for companies to stay ahead of regulations rather than reacting to them. It is unlikely that industries can completely avoid regulatory compliance needs but making strategic process improvements could eliminate a whole category of requirements (as outlined in greater detail in Case Study # 2, where a hazardous waste stream was completely eliminated by switching to a non-hazardous alternative).

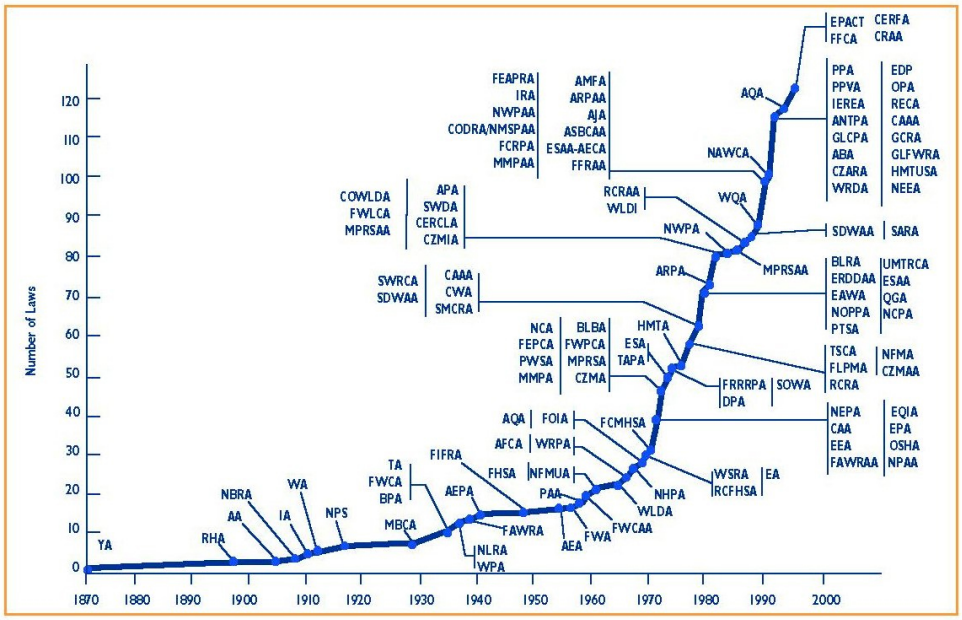

Figure 2: Cumulative Growth in Federal Environmental Laws and Amendments (USEPA)

Thus, it is observed that broadly, there exist influencing factors that have their roots within an organization and outside of the organization. This paper expands on three well-established frameworks in business and management studies to discuss these Internal and External Influencers. The frameworks that have been used to identify External Influencers include:

1. **PESTEL Analysis**: A framework for identifying and evaluating macro-environmental factors (Political, Economic, Social, Technological, Environmental, Legal) that influence the business environment.

2. **Porter's Five Forces**: This model shows the five competitive forces that shape every industry (threat of new entrants, bargaining power of suppliers, bargaining power of buyers, threat of substitute products or services and rivalry among existing competitors), and helps identify industry opportunities, weaknesses and strengths.

The framework that has been used to identify Internal Influencers is:

1. **McKinsey 7-S Framework**: A framework which shows that organizational effectiveness and change stems from the interaction of Structure, Strategy, Systems, Style, Skills, Staff and Superordinate Goals (or Shared Values) (Waterman, Peters and Phillips, 1980).

External Influencers

External Influencers can be defined as drivers or parameters that influence an organization's sustainability practices that originate outside of the organization. External influencers include, but are not limited to:

1. Changing consumer expectations
2. Changing supply chain expectations

3. Availability of sustainability programs and incentives through government/academic institutions
4. Voluntary sustainability certification programs
5. Forthcoming regulation
6. New markets (local and international)
7. Competition (local and international)
8. Market stability/economic conditions
9. Increasing material costs, both manufacturing and disposal. Example: increase in water costs

Internal Influencers

Internal Influencers can be defined as drivers or parameters that influence an organization's sustainability practices that originate from within the organization. Internal influencers include, but are not limited to:

1. Financial burden of "managing" the problem as opposed to addressing and eliminating it
2. Internal competition between facilities/ plants at different locations
3. Corporate sustainability commitment
4. Change in leadership
5. Adoption/invention of new process/ technology
6. Employee-driven initiatives
7. Hazardous waste reporting costs; filing, tracking, time
8. Size of the company
9. Availability (or lack) of resources (personnel, financial, technical)
10. Unfamiliarity with the economic value of sustainability as a paradigm
11. Voluntary sustainability certification programs
12. Reduced company liability exposure by reducing hazardous materials

During the past three years, NYSP2I has worked with small, medium, and large companies on pollution prevention efforts in New York State. Some of the small-to-medium-size companies are very progressive in viewing sustainability as a business opportunity. These companies have collaborated with NYSP2I on projects focused on toxics reduction, water and energy conservation, and waste minimization (Winnebeck, 2011). As a company begins to look at sustainability in their products life cycle, they begin to see the system and not just the product. Product life cycles are a very powerful tool since all the components of manufacturing and disposal are mapped out. Cahan, et. al. provide an excellent discussion of the product life cycle and its effect on the EHS function and corporate direction.

Other small-and-medium-size companies sometimes are challenged in making sustainability a priority, since they are limited on resources (personnel, technical, and financial) and primarily focused on meeting market demand for their products. Often these companies have a very small staff dedicated to EHS with limited scope as to the type of projects they are expected to complete. With the economic turbulence in recent years, many companies are focusing largely on staying in business. During times like this, sustainability and the implementation of sustainable environmental practices and technologies are not always viewed as strategic investments. However, in many cases the reluctance to make the necessary process changes to improve the efficiency and environmental performance of the production system is further hindering the company's competitiveness in the field. Continuing to view waste as part of the process, as opposed to a cost improvement opportunity hinders many companies from delivering improved environmental and economic performance. NYSP2I has been approached by EHS Managers at companies looking for alternative waste treatment

haulers since their current treatment method comes with a significant cost (Poduska et al. 2011). However, when teaming with EHS Managers, it is NYSP2I's mission to collaborate and develop a waste minimization strategy and develop solutions where companies will save significantly on costs by reducing their waste streams. NYSP2I must ensure EHS Managers understand the importance of the pollution prevention approach and provide them with the necessary tools and support to be able to apply the concept to other areas within their facilities.

Larger companies have their own set of challenges, often times internally and between EHS Managers and manufacturing personnel. They typically have EHS Divisions with at least one group of specialists associated with each environmental media (water, air, hazardous waste, etc.). The specialists may be responsible for supporting specific manufacturing facilities throughout the company. For years their focus with manufacturing has been on ensuring regulatory compliance, and relationships have been built with this as the central focus. EHS Managers typically did not get involved with process optimization or consult the plant managers on pollution prevention solutions. In fact, at times they may have been seen as obstacles to manufacturing progress, approaching issues with a "can't do" attitude instead of one of collaboration. However, as companies are progressing toward sustainability, the EHS Manager's role is one that needs to assist, collaborate, and sometimes drive the pollution prevention opportunities. ISO standards, and ISO 14001 (ISO 14040) specifically, have been a stepping stone for this type of collaboration between EHS Managers and manufacturing. In certain facilities, the EHS Manager is leading the ISO initiative within the facility and, therefore, has a direct line to discussing waste minimization opportunities with the plant manager, engineers, and operators. Transitioning from a supporting role for regulatory compliance to an active role of process optimization for waste reduction can present a greater challenge to both EHS and manufacturing personnel.

In some cases the EHS Managers may need to build, or rebuild, the relationship with manufacturing personnel. In order to be effective, the relationship needs to be one of a collaborative nature, not adversarial. Training and education may be required on both sides to learn about the pollution prevention approach, its advantages, and the driving force and level of priority for the company. The EHS Manager will have to balance his or her regulatory approach with one of collaboration and opportunity. Otherwise, if the relationship does not change, progress will be extremely difficult. Once the relationship is built, the EHS Manager needs to become an integral part of the manufacturing team.

In order for EHS Managers to successfully integrate themselves on a manufacturing team and make their projects a priority, they must clearly identify the business case and potential cost savings for the project they're promoting. The following are case studies of companies that have worked with NYSP2I on taking a pollution prevention approach to address their environmental opportunities. NYSP2I also witnessed firsthand both external and internal influencers associated with each company, and these instances also are presented in the case studies below.

III. CASE STUDIES

Five case studies from NYSP2I projects are presented that highlight the evolving role of EHS Managers at manufacturing organizations in New York State. The manufacturing sectors represented in the case studies are the food manufacturing/processing, glass fabrication, and plating sectors. Each case study provides background information on the organization, the role of the EHS Manager (or lack of an EHS Manager), the environmental opportunity that was identified, how it was addressed, and the

outcome of the project.

The case studies have been selected based on the involvement of an EHS Manager or a professional serving in that capacity in projects that NYSP2I has been involved with. Specifically, the case studies have been chosen since the individuals role went beyond the traditional functions of the EHS manager and incorporated the evolving attributes discussed in this paper. Multiple conversations and informational exchanges have been had with the relevant individuals at the five companies and NYSP2I has maintained relationships with these companies between two to four years. The relevant external and internal influencers (outlined in the previous section) are highlighted in each of the case studies.

III.I. CASE STUDY #1: PET FOOD MANUFACTURER, EASTERN US

III.I.I BACKGROUND

A pet food manufacturing company located in the Eastern United States has been taking proactive steps in relation to sustainability of its food manufacturing process. The company, which serves a variety of market segments in terms of product type and geography, has been actively seeking assistance to reduce the quantity of resources such as raw material, energy, and water utilized in its manufacturing process. The company is trying to simultaneously reduce the quantity of waste generated, for example, solid waste, wastewater discharge, and wasted resources such as energy, labor, raw material, and water due to process inefficiencies and rejected product. Listed below are the external and internal influencers that have motivated this paradigm shift toward sustainability.

External Influencers

1. Changing consumer expectations
2. Availability of programs and incentives through government/academic institutions

Internal Influencers

1. Internal competition between facilities/ plants at different locations
2. Corporate sustainability commitment
3. Availability (or lack) of resources (personnel, financial, technical)

At the company, sustainability is being embraced as a model that enables and encourages processes to perform at their highest efficiency level, allowing a reduction in costs and environmental impact while increasing efficiency, productivity, and profitability. This efficiency has a direct impact on market perception in a rapidly evolving marketplace that expects some degree of measurable sustainable outcomes (the extent may vary) from manufactures, suppliers, and vendors, thus improving competitive positioning and potentially increasing market share. Plant-to-plant (internal) competition allows self-evaluation, internal benchmarking, and internal sharing of sustainability information.

The role of the EHS Manager at the company is shared between two positions: the Environmental Coordinator and the Health and Safety Manager. The team involved in steering the organization toward its sustainability goals and metrics includes both of these positions. By splitting the roles between two individuals, the Environmental Coordinator has greater latitude and flexibility in engaging directly and deeply with manufacturing operators/operations. The Environmental Coordinator continues to be responsible for the tracking and regulatory reporting requirements in regard to wastes (hazardous and solid), wastewater discharge permits, and air permits. However, once freed from meeting the internal Health and Safety responsibilities (such as providing training, addressing internal concerns,

and incidents), the Environmental Coordinator has been able to take a proactive approach in improving the sustainability performance of the company.

The Environmental Coordinator is involved in various plant-wide initiatives addressing energy and water conservation and reducing raw material waste, which is driven by a corporate program that was instituted in recent years. Specifically, the company has been working with NYSP2I over the last year in understanding the current state of their solid waste stream and analyzing quantified solid waste data from the production process. The data gathering process and analysis were greatly facilitated by the strong working relationship between the Environmental Coordinator and manufacturing personnel.

III.I.II. ENVIRONMENTAL OPPORTUNITY:

The total annual solid waste disposal cost incurred by the entire facility (which is comprised of two industrial units for two product groups) was approximately $500,000 in 2009. In addition, one product group (which consists of three different products and has similar manufacturing processes) had high material costs, and the average cost of raw material lost per ton of waste generated was $1000. Thus, the total economic loss (including tipping fees + transportation costs + cost of lost raw material) as a result of solid waste generation from the facility was greater than $2 million annually.

NYSP2I has worked with a team at the company, which was co-led by the Environmental Coordinator, in analyzing the solid waste data that was gathered from the production process. While data was being tracked, NYSP2I assisted in the data analysis and provided a quantitative summary indicating the production processes that contributed most significantly to waste generation. The primary solid waste generated from the product group with high raw material costs is organic food waste, and one process step (Step A) contributes to nearly 60% of the waste generated, as shown in Figure 3.
While the process that is the largest contributor to

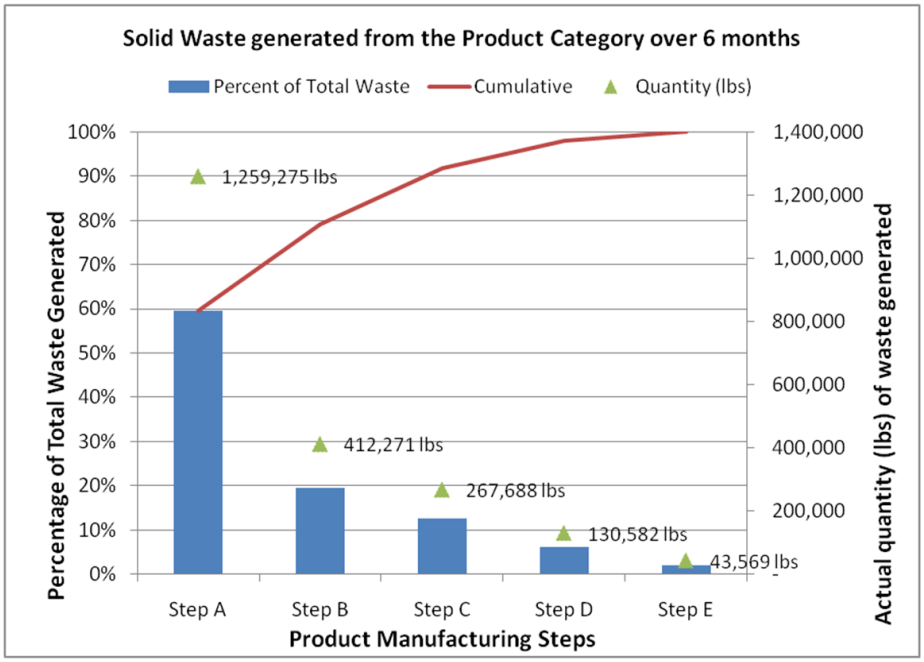

Figure 3: Solid Waste Generated during Manufacturing

waste generation has been clearly ascertained, the root cause or causes remain unclear. Therefore, a root cause analysis is being initiated to identify the underlying factors resulting in such high volumes of waste generation. The 6Ms (man, machine, material, measurement, management, and method) will be evaluated to determine these factors. Solutions will then be researched, evaluated, and implemented to reduce or eliminate the generation of waste. The combination of corporate sustainability goals and a solid connection between manufacturing and the Environmental Coordinator is setting the stage for significant reduction in waste due to process improvements. Also, the fact that the company created a dedicated position for environmental issues puts the company in a better position to act on sustainability opportunities.

III.II. CASE STUDY #2: GLASS FABRICATOR ROCHESTER, NY

III.II.I. BACKGROUND:

A glass fabricator located in Rochester, NY, manufactures glass blanks for other industries. The company is small and does not have a dedicated EHS position; instead, the Facilities Manager had this role. The company's glass processing steps include the use of adhesive to hold the glass in place for cutting operations. After the cutting operation is finished, the residual adhesive must be removed from the finished glass blanks. In the past, adhesive removal was accomplished by soaking the parts in methylene chloride.

As part of his many duties, the Facilities Manager was responsible for hazardous material disposal, as well as process safety and safety training. The use of methylene chloride in the facility required a separate ventilation system for the methylene chloride vapors in the processing area, special safety equipment, and hazardous material training.

As part of his facility goals, the Facilities Manager was working toward reducing or eliminating hazardous materials and hazardous waste.

External influencers:

1. Increasing material costs, in this case the cost to purchase and dispose of methylene chloride

Internal influencers:

1. Financial burden of "managing" the problem as opposed to addressing and eliminating it
2. Hazardous waste reporting costs; filing, tracking, time
3. Reduced company liability exposure by reducing hazardous materials

III.II.II. ENVIRONMENTAL OPPORTUNITY

There were two waste streams from the original adhesive removal process, adhesive sludge with small amounts of methylene chloride and the adhesive saturated methylene chloride. In 2009 the glass fabricator disposed of six 55-gallon drums of the sludge and spent methylene chloride. Both waste streams are considered hazardous due to the presence of the residual solvent. The Facilities Manager wanted to find a less hazardous or, preferably, a non-hazardous means of removing the adhesive from the glass blanks. The potential risk in replacing the methylene chloride was a slower process. Alternative materials could have been significantly more expensive. These disadvantages can be the process trade-offs when attempting to develop a more sustainable process.

After much research, the Facilities Manager found a solvent that was not only non-hazardous but also worked better than the methylene chloride.

This solvent improved the process by increasing the part cleaning rate and completely eliminated the hazardous methylene chloride waste streams. The glass fabricator has been using this new solvent successfully for almost a year. This alternative eliminated a total of approximately 3600 lbs. of methylene chloride hazardous waste per year based on the 2009 disposal amount. This solution also led to other advantages, including the elimination of methylene chloride, Toxic Release Inventory (TRI) reporting, elimination of both safety training and safety equipment necessary for this chemical, and elimination of fume exhausting, resulting in cost savings in regard to heating the facility.

Although certainly not always the case, there are times when looking for sustainable solutions results in both waste elimination and a process improvement, in this case a faster process. The financial and administrative burden of permitting, reporting, and regulations also can be lifted as sustainable solutions are implemented. The Facilities Manager had been gradually extending his responsibilities beyond that of meeting the standard environment, health, and safety requirements to being proactive and looking for pollution prevention opportunities. This stance enabled him to completely eliminate a hazardous material from the operation by examining the detailed process requirements. In a small company the EHS responsibilities can fall to an individual with many other responsibilities. In this case, the individual was self-driven to create sustainable solutions that coincidentally provided process improvements.

III.III. CASE STUDY #3: PLATING SHOP 1, ROCHESTER, NY

III.III.I. BACKGROUND

Plating Shop 1 is a metal finishing job shop in Rochester, NY, that specializes in advanced and proprietary industrial coatings and plating. The metal finishing services offered include electroless nickel plating, anodizing, passivation of stainless steel, zinc plating, aluminum conversion coatings, and other specialty processes. This plating shop has been involved with sustainability improvements for many years. Six years ago it found a means of reducing both its acid use and acid waste, so the idea of becoming more efficient with its resources has a long history with the company.

The role of the EHS Manager is divided between two people: the Plating Lab Manager and the General Manager. The Plating Lab Manager handles the environmental aspects of plating such as handling wastewater treatment sludge and monitoring the outgoing treated water. The health and safety responsibilities are handled by the General Manager. The Chairman of the company is highly interested in sustainability, so the drive to improve water use and chemical use is a top-down priority for the company. Having this kind of support from the CEO is extremely helpful when initiating pollution prevention projects.

External influencers:

1. Availability of programs and incentives through government/academic institutions
2. Increasing material costs, both manufacturing and disposal, for example, water costs

Internal influencers:

1. Corporate sustainability commitment
2. Size of the company—small and lean
3. Availability (or lack) of resources (personnel, financial, technical)

III.III.II. ENVIRONMENTAL OPPORTUNITIES:

The company Chairman was concerned about the amount of water used at his facility and was interested in finding a means of reducing the overall water footprint. This solution would have the impact of reducing the cost of water purchase, wastewater treatment, and water sewer charges. The company's annual water use was approximately 7.6 million gallons at a cost of $40,000 in 2009.

The major water use was in rinsing parts between process tanks for the various finishing lines. The NYSP2I provided some baseline rinsing measurements on three of the company's high water use lines. Rinse flow rates are important in predicting annual water use estimates as well as finding rinse tanks with either unusually high or low flow rates (lack of flow control). It was determined that the shop could reduce its rinse water use by a technique known as reactive rinsing. This plating shop had six sets of rinse tanks that could benefit from this method of rinse water reuse. Figure 4 illustrates the typical tank sets that can be used for reactive rinsing and that were used at this facility. After all the systems were running properly, the shop was able to save 1.4 million gallons per year or approximately 18% less water per year. This represents a water savings of approximately $7,700 per year for an investment of less than $1,000. Although the project was successful, there were implementation delays. One challenge with their corporate structure was that the Environmental Manager was at a lower level than the Health and Safety Manager, and it appeared that he did not feel empowered to implement the rinse water changes even though the Chairman felt water use reduction was important. Therefore, an opportunity for improvement would be ensuring that there is clear and uniform management support of process improvements that incorporate environmental initiatives. This management empowerment problem was discussed by Volkmar, et. al. as one of five EHS management challenges. They called it "Challenge No. 1: Top Management Participation" and "The Importance of Authority".

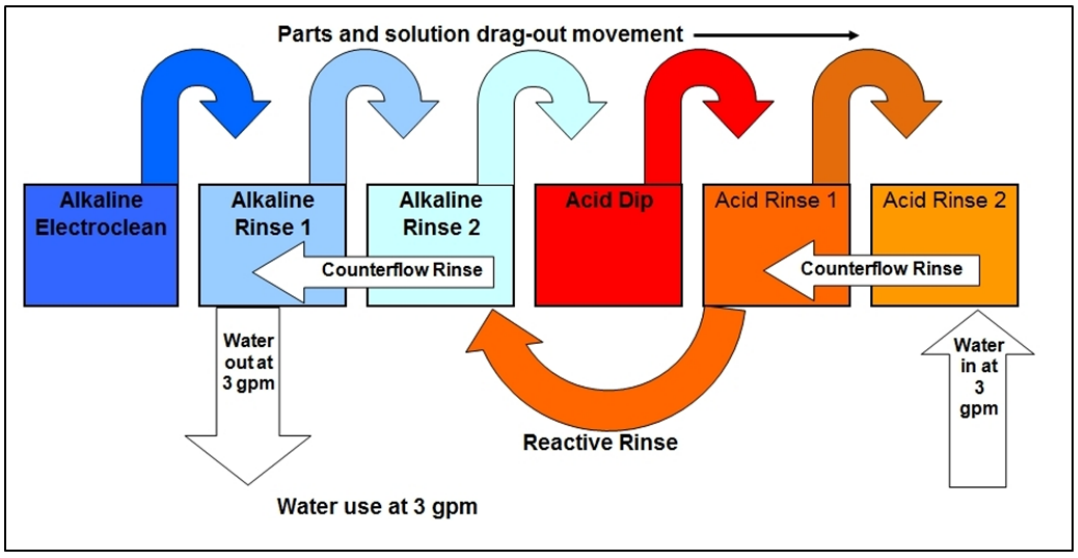

Figure 4: Schematic showing the water flow in a Reactive Rinse

III.IV. CASE STUDY #4: PLATING SHOP 2 IN WESTERN NY

III.IV.I. BACKGROUND

Another Upstate New York plating job shop had investigated ways to reduce its environmental footprint but had somewhat limited engineering resources to investigate opportunities. The company has three plating lines, each with numerous rinse tanks. Rinse rates were controlled by the operators using water valves to control the flow rates on each rinse tank. As with most plating companies, the plating line wastewater is treated on site to remove metals and adjust the pH before discharging its water into the city sewer for final treatment by the publicly owned treatment works (POTW). It also had relatively large volumes of waste acid to treat on site each year from the acid etch tanks and their rework stripping tanks.

Going beyond meeting the regulatory requirements was a new endeavor for their EHS Manager, and pollution prevention opportunities were being pushed to a low priority by day-to-day activities. A project was set up with the NYSP2I to determine the opportunities that were feasible for acid savings and water savings. Flow rates were measured for all the rinse tanks, and acid use was estimated based on the frequency of acid tank dumping and refilling. The company was already reusing the water from the cleanest rinse tanks by sending the water through an ion exchange system and then sending it back to the lines.

External influencers:

1. Availability of programs and incentives through government/academic institutions
2. Increasing material costs, both manufacturing and disposal

Internal influencers:

1. Hazardous waste reporting cost; filing, tracking, time
2. Hazardous waste treatment costs (in-house wastewater treatment)
3. Availability (or lack) of resources (personnel, financial, technical)
4. Unfamiliarity with the economic value of sustainability as a paradigm

III.IV.II. ENVIRONMENTAL OPPORTUNITIES

There were three potential opportunities for improving the environmental footprint for this company: acid waste reduction, treated wastewater recovery, and conductivity-controlled rinse valves. The company was able to use an acid additive that prevented dissolved metal from building up in the acid tanks as metal is being etched. This additive extended the life of the acid tanks by at least double their normal life. The acid savings are expected to be at least $7,400 per year.

This plating shop had relatively clean water coming from its wastewater treatment. The only drawback from reusing this water was its salt content, which was too high for direct reuse and too high for its ion exchange systems. The technically feasible solution for reusing at least 32% of this water was the use of reverse osmosis to remove approximately 99% of the dissolved salts. However, recovery of 32% of the treated wastewater using a Reverse Osmosis (RO) system is $16,700 per year on a 15,000-gallon-per-day RO unit. The RO unit was expected to cost over $60,000, so the annual payback of $16,700 in water savings did not meet the company's economic requirements on this proposed solution.

Finally, the rinse water flow rates were operator controlled. The shop installed one trial

water valve controlled by water conductivity to regulate the rinse water flow based on the contaminant level to one rinse tank. This system overrides operator control of the water and shuts off when the line is idle. This option is still being tested as an alternative to operator-controlled rinses. If successful, multiple control valves will be installed on the rinse tanks. The impact will be that rinse water can run at a high or low rate as determined by the operators. However, the water will flow only while contaminants are being diluted out of the rinse tanks to a preset contaminant level. After that level is reached, the water will automatically shut off. During idle periods on the plating lines, all the rinses will shut off automatically rather than previously relying on the operators to turn all the valves off.

The overall results of the initial study for this company were positive and the EHS Manager has a better understanding of the plating process rather than just knowing and focusing on the wastewater treatment process. Overall process knowledge becomes necessary for the role of the EHS Manager when it goes beyond the waste and regulation aspects and expands to efficient material use or efficient material recovery. The reverse also is helpful, where the plating process engineers begin to understand what can cause the waste treatment process to work better (or worse). The plating department personnel were concerned that changing the rinsing process would be detrimental to the plating process by potentially causing plating defects. At that time environmental improvement goals were not mandated through corporate policy. Therefore, the EHS Manager was unable to initiate water use changes upstream of the waste treatment process. Obviously, process changes to improve sustainability can never be made at the cost of product quality. On the other hand, the cost of a process and its downstream costs should be continuously re-evaluated to look for improvement opportunities.

III.V. CASE STUDY #5: FOOD PROCESSOR IN NEW YORK CITY

III.V.I. BACKGROUND

This company is the processor of specialty fish products. It purchases its fish in the frozen state and must thaw them before going further in its process. In the food industry, thawing is commonly accomplished with water. For food safety, this water is constantly flowing to prevent potential bacterial growth. There are really no other regulatory problems at this stage of the food process. During a facility assessment by an outside consultant, the CFO was informed that, although no regulatory issues existed with the way the company was using the water, there were certainly concerns about the company's usage of extremely large volumes of water just to thaw the fish.

External influencers:

1. Availability of programs and incentives through government/academic institutions Increasing material costs, both manufacturing and disposal, for example, water costs

Internal influencers:

1. Availability (or lack) of resources (personnel, financial, technical)

III.V.II. ENVIRONMENTAL OPPORTUNITIES

The company contacted the NYSP2I to obtain technical support in determining options for reducing its water consumption. The use-tempered water (warmed to a set moderate temperature

by mixing hot with cold) thawing was modeled to estimate the change in water use. The model suggested that the company could conservatively save almost 23,000,000 gallons of water per year. Its typical annual water use was close to 30,000,000 gallons per year, so its water use could be decreased by approximately 75%.

In addition to the enormous water savings, the use of tempered water was found to have another positive effect on the thawing process. The wintertime incoming water temperatures could be as low as 35ºF, resulting in extremely slow thawing rates. The summer water temperatures were the reverse with very short thawing times. Therefore, the thawing rates varied dramatically over the course of the year resulting in the need for constant process adjustment. The use of tempered water year round meant a very stable and predictable thawing process.

As an added cost benefit, the facility has access to excess heat that will be used for heating and storing hot water. This water will serve as the tempering water to bring the incoming cold water up to the required temperature without the use of any additional heating fuel. Therefore, their pollution prevention solution utilizes less water and no additional heating and provides a more predictable process.

The company is very lean on staffing and does not have a dedicated position for either EHS or sustainability. However, the company CFO knew there was a significant cost associated with water use but did not know how to approach it. Both a lack of staff and a lack of technical resources due to company size were hindering this company from moving forward on the sustainability continuum. After observing the pollution prevention approach to reduce their water consumption, the CFO and staff now had a better understanding of their thawing process and how to control it. They also have a better understanding of how to approach similar problems in the future and the approach to use in reducing their environmental footprint. In this case, the small size of the company resulted in a lack of internal staffing and technical resources to manage EHS issues. They were able to make use of external technical resources and external funding to improve their process sustainability.

IV. THE POLLUTION PREVENTION (P2) APPROACH AS APPLIED TO THE EVOLVING EHS ROLE

The pollution prevention mindset is a shift in approach for both the EHS Manager and the manufacturing facility. The EHS Manager needs to broaden his or her perspective of waste and look at waste as an opportunity to reduce costs and improve the process, instead of another stream to treat and dispose. The EHS Manager needs to immerse himself/herself in the manufacturing facility to fully understand the material inputs, outputs, environmental waste streams, and by-products of the manufacturing process. By quantifying the current state of the process (i.e. understanding the baseline), the prioritization of opportunities related to large waste streams or costs associated with the waste streams can be completed. NYSP2I has found the following steps to be effective when implementing pollution prevention solutions, particularly when the EHS Manager is taking the lead and working with manufacturing personnel.

1. Build strong working relations with manufacturing or operations, a collaborative vs. regulatory approach
2. Educate key personnel on benefits of pollution prevention and sustainability initiatives—through training programs or attending conferences
3. Focus on the direct impact to the bottom line to obtain buy-in from both management and manufacturing personnel

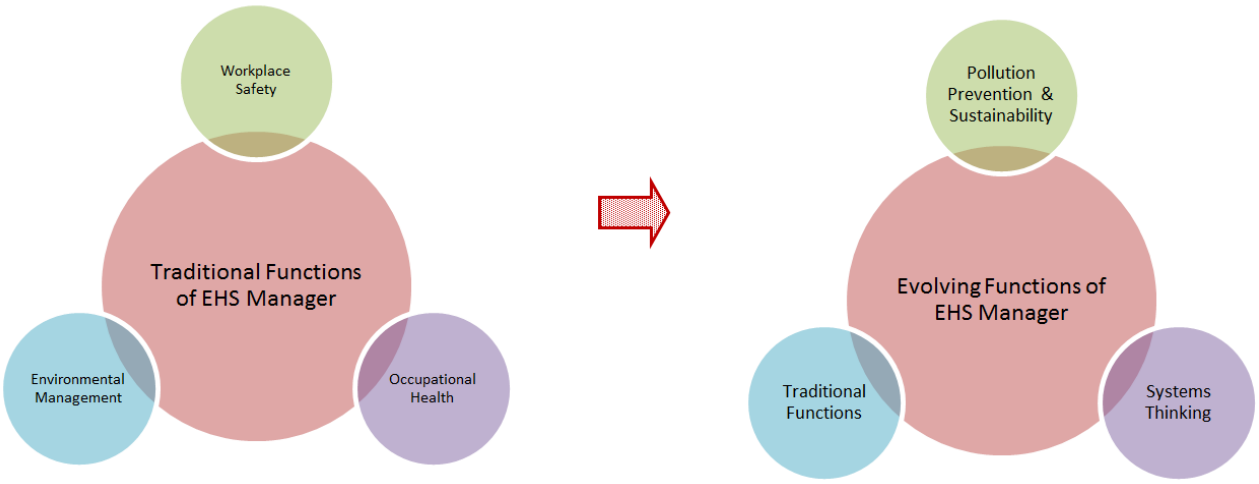

Figure 5: Evolving Role of the EHS Manager

4. Develop the baseline; quantify the current state of the process (often entails material and energy input-output analysis)
5. Identify opportunities for environmental improvements and cost reduction
6. Prioritize opportunities
7. Obtain buy-in from upper management on the top opportunities
8. Seek out experts (consultants, universities, P2 organizations) to aid with prioritization, assessments, and implementations
9. Seek out funding opportunities (state, federal, other stakeholder organizations) to offset the cost of implementing sustainable practices/technologies

These steps were developed by the NYSP2I staff as they developed a history of successful and unsuccessful projects with the New York State companies. Successful implementation of pollution prevention recommendations typically had most of these steps in place. Unsuccessful or stalled implementation projects typically had multiple steps missing or incomplete. In order for EHS Managers to successfully integrate themselves on a manufacturing team and make their projects a priority, they must clearly identify the business case and potential cost savings for the project they are promoting. The emerging role of the EHS Manager needs to incorporate a balance of compliance, regulations, and reporting with pollution prevention, process optimization, and systems thinking, as shown in Figure 5.

The modern revelation is that waste can be viewed as both an environmental improvement opportunity and a cost-savings opportunity. This spectrum of companies and their respective roles for EHS managers is represented in the Sustainability Continuum created by the NYSP2I and shown in Figure 6. However, a large gap still exists between companies that have invested in sustainability and pollution prevention initiatives and companies that still view waste as an unavoidable part of their manufacturing process.

The Sustainability Continuum provides a visual representation of an organization's position in the context of its adoption of sustainable practices (specifically in the realm of environmental sustainability). The continuum also focuses on a few critical parameters that enable

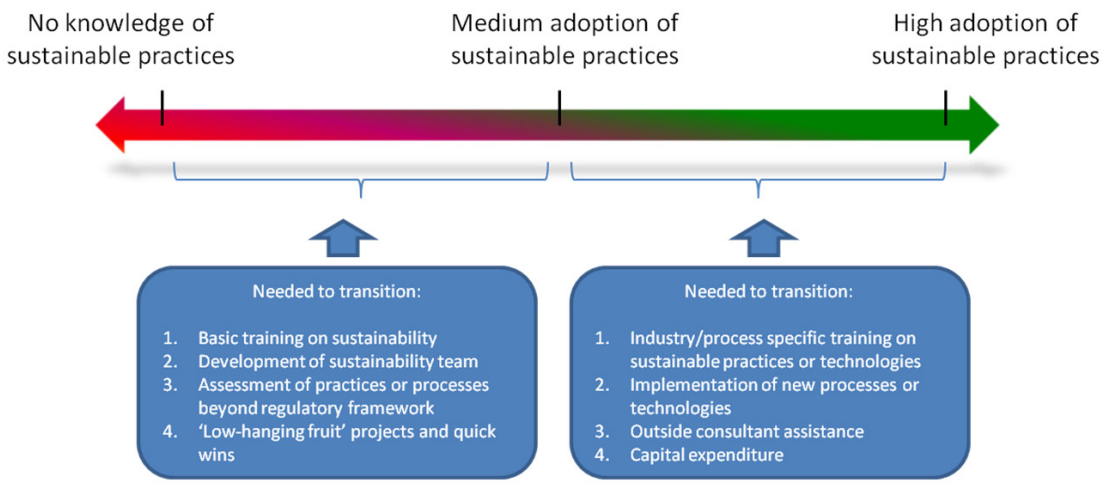

Figure 6: Sustainability Continuum

the transition from one phase to the next in regard to progressive sustainability. The operational, manufacturing, purchasing, and logistical practices of any organization dictate where it sits on the Sustainability Continuum. This point can range from having little to no intentional adoption of sustainable practices or strategy, to the implementation of short- and long-term corporate sustainability initiatives woven into annual performance goals. A variety of parameters influence an organization's position and journey along the continuum and can move a company forward, backward, or keep it stationary. These movement influencers can be broadly divided into external (or macro) and internal (or micro) influencers. These lists were compiled from the combined experiences of the NYSP2I staff as they worked with companies on pollution prevention projects. The influencers were the reasons stated by the companies or observed by the NYSP2I staff as they worked through the projects with company EHS managers.

The role of the EHS Manager is highly dependent on where the organization is on the Sustainability Continuum. In other words, the EHS role is influenced by a combination of external and internal influencers. The size of the company on the continuum relative to number of employees (small <100, medium <500, or large >500) can also present its own set of challenges for EHS Managers and their emerging role in sustainability.

V. CONCLUSIONS

There are many variables that need to be taken into account when companies assign responsibilities to the role of the EHS Manager, including internal and external influencers, company size, and company position on the Sustainability Continuum. Understanding these variables and considering the challenges and opportunities faced by the EHS Manager will enable the organization to move toward a pollution prevention and sustainability approach in developing solutions to its environmental problems. The key findings in relation to the evolving role of the EHS Manager in light of sustainability are that:

> *There is no single influencer that can cause a positive sustainability shift in a business entity*, as evidenced by the case studies. There are positive influencers that, working together, can cause major sustainability

improvements. For example, in a small company a combination of management recognition and commitment to sustainability, along with technical expertise, whether internal or external, will typically produce a positive sustainability shift. Even the cost of regulatory compliance, such as waste filing, tracking, and time, can produce enough non-value-added costs to justify changing a process to a more sustainable one. (Note that regulatory pressure can have the negative sustainability effect of moving a "dirty" process off shore rather than creating a positive on-shore change.)

The role of an EHS Manager and the shift to a pollution prevention and sustainability approach can be a self-directed change as demonstrated by case study 2 with the glass fabricator. However, the shift requires empowerment from inside influencers, such as corporate sustainability goals that cover all of manufacturing and, therefore, minimize conflicting corporate goals.

The EHS Manager can positively affect company sustainability if the role allows time for sustainability activities. Two of the case studies had split the responsibilities of health and safety activities from environmental activities to allow equal and greater focus on both of these important aspects of a well-run company.

In very large companies where there may be two or more individuals responsible for various environmental aspects of the business, a level reporting structure helps keep the goals uniform. For example, two environmental engineers in the company should report to the same manager to avoid conflicting goals or duplicating efforts.

The EHS Manager's role must be more integrated with the manufacturing environment of the business to be able to successfully implement sustainability improvements. This role change requires the EHS Manager to become more knowledgeable about the needs of the manufacturing processes. Simultaneously, manufacturing needs to better understand the impact of waste on the cost of the business.

A key driving factor behind organizations focusing their efforts on sustainable measures are corporate initiatives and programs that encourage and incentivize employees and facilities to adopt sustainable practices. These motivators greatly enable the initiation of sustainability projects at the operational level and could be viewed as an advanced stage in the evolution of the organization and, consequently, the role of the EHS Manager.

Thus, the role of the EHS Manager in manufacturing organizations continues to evolve as enterprises and industry sectors move toward sustainability. The needs of different organizations and sectors, as they traverse the Sustainability Continuum, are different based on the internal and external influencers discussed. While there is no "one size fits all" solution that can be broadly implemented across manufacturing organizations to enable sustainable development, Institutes such as NYSP2I, government initiatives, and academic research are the resources that can provide guidance along the way in developing sustainable solutions. These resources can reinforce the pollution prevention and sustainability paradigm, thus paving the way to a sustainable future.

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